Gait Characteristics in Knee Osteoarthritis Patients Before and After Knee Replacement

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Summary:

The aims of this thesis were to provide insight into functional limitations in knee osteoarthritis patients and in recovery after knee replacement; therefore we investigated the walking speed in knee osteoarthritis patients as the most reliable and easy measure of function. In Chapter 2, a meta-analysis of effect of KR on walking speed revealed large heterogeneity of effect- size on the short-term after surgery, which was a problem in the valid estimation of overall effect size. But in latter periods KR has a large effect on walking speed, possibly large enough for return to the level of healthy peers. Meta-regression analysis gave significant effects of time and time squared, suggesting initial improvement and then decline of walking speed after knee replacement, probably because of the presence of co- morbidity and aging. A possible advantage of having a lower walking speed in knee osteoarthritis patients may be to keep λ_L sufficiently low (more stability), also patients may avoid high walking speed to keep variability of both knee and trunk movement down, thereby possibly reducing the extent of self-generated perturbations and/or to maintain sufficient stability and safety margin of trunk movements.

In Chapter 3, we compared gait kinematics and objective stability between osteoarthritis patients and controls, and followed patients for 1 year after knee replacement. Patients walked with reduced variability of sagittal knee movement compared to healthy peers, particularly on the affected side, post-operatively even more so. Variability was positively related to number of falls in the patients. The results of this study suggested that reduced variability is a strategy rather than a sign of pathology.

Pre-operatively, sagittal plane knee movement of the unaffected leg of the patients was more unstable than in the healthy peers. There were some possible interpretations to explain instability in the unaffected leg. Patients may have paid selective attention to the affected leg while “letting go” the unaffected leg. Also performing corrections with the unaffected leg to limit variability of knee movement in the affected leg around foot placement may have resulted in lower unaffected leg stability. Another interpretation can be that the affected leg influences the kinematics of the unaffected leg during swing and at foot placement. Finally patients showed more pronounced frontal plane trunk sway toward the unaffected leg, which may disturb stability of the unaffected leg. One year after the operation, this problem with unaffected leg stability had disappeared, suggesting recovery, but trunk movements at follow-up remain to be investigated.

Chapter 4 focused on muscle co-contraction in knee osteoarthritis patients. In two muscle pairs of the patients’ unaffected legs, co-contraction time was longer than in the healthy peers. The presence of more pronounced lateral trunk sway toward the unaffected leg in the patients could be an explanation of longer co-contraction in the unaffected leg. After knee replacement, co-contraction time decreased in six out of ten muscle pairs, indirectly confirmed the idea of general co-contraction in severe knee

osteoarthritis patients. Patients with varus alignment used longer co-contraction, mainly on unaffected side muscles. Therefore, a speculative explanation may be that worse alignment of the affected leg coincides with more pronounced trunk frontal plane sway toward the unaffected leg. Instability of sagittal knee movements predicted more co-contraction. Patients co-contract probably to stabilize the knee, which does not necessarily decrease the risk of falling.

In Chapter 3 we hypothesized that osteoarthritis patients probably reduced their sagittal knee movement variability by stiffening their knee via muscle co-contraction. We found negative regressions between affected side variability and unaffected side co-contraction time, particularly at the lower speeds. Patients may need to stiffen their unaffected leg by having longer co-contraction to achieve precise foot placement of affected leg. Variability decreased further after the operation, when patients co-contracted shorter. The reduction of co-contraction and variability post-operatively may be due to pain reduction and correction of malalignment, while a mechanism other than co-contraction to reduce variability of knee movement my also become operative.

In Chapter 5 we studied trunk kinematics related to gait stability and possible strategies to improve balance in knee osteoarthritis patients, healthy elderly, and healthy young adults. Both elderly groups showed reduced local dynamic stability of trunk movements in the frontal plane (i.e. a higher λ_S) compared to the young. In comparison to young healthy adults, elderly with and without knee osteoarthritis used wider steps and shorter strides, presumably to stabilize gait in the frontal plane. In the healthy elderly, this resulted in an increased margin of safety of the projection of frontal plane thorax position relative to the base of support. However, the knee osteoarthritis patients mainly used another strategy, changing the relative timing of thorax movements and foot placement, which led to a leaning over, mostly at the unaffected side. This may be a strategy to quickly unload the affected leg at the beginning of stance, or it may result from abductor weakness, whereas at the affected side, leaning over is probably a strategy to reduce loading the medial side of the knee. Hence, patients appear to prioritize pain, or suffer from abductor weakness, and their leaning over will compromise their balance, which may be the reason they fall more often.